ROYAL ASTRONOMICAL SOCIETY.

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Rev. R. SHEEPSHANKS, V.P., in the Chair.

Robert Grant, Esq., 5 Priory Villas, Islington;
Marcus Warburg, Esq., 29 Burton Street; and
Thomas Bowden, Esq., 51 Pall Mall;
were balloted for and duly elected Fellows of the Society.

His Majesty the King of Hanover has granted the honorary gold medal for Art and Science to our Associate Dr. Rümker, director of the School of Navigation at Hamburg.

Letter from Mr. Lassell to the Astronomer Royal.

"*Starfield*, 14 *August*, 1850.

"My dear Sir,—I have strong reason to suspect that I have to-night detected a second satellite of *Neptune*.

"Last night, the 13th inst. at about $11^{h}.0$, I observed the satellite of *Neptune* for the first time this season, and made a diagram of it, the satellite being towards its *southern* elongation. The sky was extremely unfavourable; and finding that no measures of either position or distance could be taken with any chance of accuracy, I attempted none.

"To-night, in a somewhat better, but still bad sky, I see what I conceive to be *another* satellite, in the line of *northern* elongation of the old satellite, and about two diameters distant.

"This cannot well be the satellite already known, which ought to be almost preceding the planet, and in that position is generally invisible. There can be no question of the reality of the observations; the satellite of to-night (considerably fainter than that of last night) being repeatedly and almost constantly seen with various powers, *e.g.* 316, 479, 628. The position of the satellite is, as I have said, very nearly in the direction of the greatest northern elongation of the old one, and, being barely two diameters of the planet distant, may probably be interior to it.

"The sky became cloudy shortly after eleven and remained so, which prevented any confirmatory observations of motion. But I think the hypothesis of a fixed star of a similar magnitude and in the precise direction being located there, is too unlikely to throw much doubt upon the discovery."

Extract of a Letter from Professor Hansen to the Astronomer Royal.

"*Gotha*, 1850, *June* 27.

"The work on the Lunar Tables is advancing daily, but we have not yet gone so far as to enable me to communicate to you any result. In respect, however, to the moon's motion since the more distant ages, I am able to inform you, that an assistant, to whom I committed last year the task of comparing the ancient eclipses with the tables of the present day, has found, from the nineteen eclipses of the Almagest, a motion of the moon's node, which agrees in a remarkable manner with that which you have deduced from the Greenwich Observations from 1750 to 1830. According to his statement, he has found the correction of Damoiseau's secular motion of the node to be

$$+1''.643,$$

while your investigations have given

$$+1''.721,$$

a most surprising agreement. These corrections also agree with my theory as nearly as can be desired. Thus the view which Professor Seiffarth, of Leipzig, has explained, according to which a very important correction of the motion of the moon's node is deduced from the ancient eclipses, appears to be incorrect."

At the meeting of May 10, the President gave an oral account of a new arrangement of the double-image micrometer. Referring to a paper in the *Memoirs* of the Society, in which the general structure of the four-glass eye-piece, with the second lens (reckoning from the object-glass) divided, is described, and in which the equations of achromaticity are investigated, he showed that three equations only are given between seven quantities (namely, the four focal lengths of the lenses and the three intervals between them), and, therefore, that any four of the quantities may be assumed. This circumstance permits an infinity of different forms of solution. One form, which appeared generally convenient, was indicated in the memoir, and it has been found in practice to be perfectly successful as regards the special object of the theory, and to be subject only to two small practical inconveniences; that the field of view is rather contracted, and that a rather rapid screw is required for the micrometer, by which one-half of the divided lens is made to slide past the other. The President then stated that he had received a communication from Mr. Valz, of Marseilles, in which that gentleman had pointed out to him that the equations might be satisfied in a form which would give a larger field of view, by using for the divided glass a *concave* lens; and the President stated that he had immediately perceived that the construction would possess these two further advantages,—that a slower screw would suffice, and that, in consequence of the thinness of the

lens near the middle, very little light would be lost if the pencils of light were somewhat inclined to the axis of the telescope (the effect of the central thickness of a convex lens being that, if the pencils are at all inclined, a large proportion of the light is lost, more especially for the high magnifying powers.) The numbers which Mr. Valz pointed out are the following:—

Focal length of 1st lens, or that nearest the object-glass, arbitrary, or ...	*a*
Distance from 1st lens to 2d lens, the same as focal length of 1st lens, or	*a*
Focal length of 2d, or divided lens (which is concave)	1
Distance from 2d lens to 3d	1
Focal length of 3d, or field-glass	1
Distance from 3d to 4th	3
Focal length of 4th, or eye-glass	1

where the numbers 1 and 3 may be applied to any scale of linear measure whatever.

The next thing to be considered was the curvatures of the surfaces of the lenses. And here it is to be remarked that the accurate use of the double-image micrometer requires, both that the images be distinct, and that the images (considered as parts of the large image covering the whole field of view) be not distorted. The President had thought it probable that, for the higher powers, in which the pencils of light are very narrow, the first condition might be practically sacrificed to the second; but, upon trying surfaces which were better adapted to prevent distortion than to avoid indistinctness, the injurious effect on the definition was so striking, that he had determined to confine himself to the first condition. For securing this, the following rule is, in practice, sufficiently accurate:— Find, on one side of each lens, the place of intersection of the axes of pencils with the axis of the telescope; and on the other side, the place of intersection of the rays of light in a single pencil: if these are equidistant, the lens ought to be equiconvex: if the distances are unequal, the nearer of the two points ought to have the less convex surface. Applying this rule to the construction in question, the following are found to be proper forms:—

First lens, equiconvex.
Second, or divided lens, equiconcave (it is here nearly a matter of indifference).
Third, or field-glass, plano-convex, with its plane side next the divided lens.
Fourth, or eye-glass, equiconvex.

The eye-piece, constructed according to these rules, appears in practice to be excellent. Several change-lenses are provided for the first lens (their framing being so prepared that they necessarily take the proper distance from the divided lens), and in all the performance is extremely good. The images of stars are sensibly more round than those seen in the other constructions. There is no sensible distortion.

The eye-pieces, upon which the President's experiments have been made, were constructed from the numbers above given by Troughton and Simms.

JUNO.

DURHAM. Fraunhofer Equatoreal. (Mr. R. C. Carrington.)

1850.	Greenwich M.T.	R.A.	Comp^{d}—Obs^{d}.	N.P.D.	Comp^{d}—Obs^{d}.	Set.
	h m s	h m s	s	° ′ ″	″	
May 1	13 14 14·8	13 3 50·53	+3·15	86 25 15·6	+13·7	(1)
2	14 30 57·1	3 12·28	3·52	20 27·6	13·8	(2)
6	12 14 12·2	13 1 1·66	+2·74	86 4 22·1	+12·1	(3)

Stars of comparison for *Juno*.

Name.	Ass^{d} App^{t} R.A.	No. of diffs. taken.	Ass^{d} App^{t} N.P.D.	No. of diffs.	Set.
	h m s		° ′ ″		
Weisse XIII. No. 62	13 4 46·46	12	86 32 58·5	4	(1)
B.A.C. 4436	13 7 57·17	12	86 9 24·0	4	(2)
Weisse XII. No. 1044	13 0 24 34	26	85 56 34·9	9	(3)

(Set 2.) The fourth set of comparisons was unfavourably made.
(Set 3.) Star too close for convenience.

The observations were taken with an eye-piece having five meridian wires and two moveable declination wires; the wires were faintly illuminated in a dark field.

The observations are corrected for refraction and parallax; the parallaxes and data for *Iris* being taken from the supplement to the *Nautical Almanac* for 1853.

IRIS.

DURHAM. Fraunhofer Equatoreal. (Mr. R. C. Carrington.)

	Greenwich M.T.	R.A.	Comp^{d}—Obs^{d}.	N.P.D.	Comp^{d}—Obs^{d}.	Set.
	h m s	h m s	s	° ′ ″	″	
May 4	14 38 19·7	15 44 36·56	+0·15	113 29 32·7	+5·3	(1)
5	13 42 41·2	15 43 41·72	+0·51	113 25 49·8	+2·3	(2)

Stars of Comparison for *Iris*.

Name.	Ass^{d} App^{t} R.A.	No. of diffs. taken.	Ass^{d} App^{t} N.P.D.	No. of diffs.	Set.
	h m s		° ′ ″		
B.A.C. 5254	15 45 2·72	4	113 31 31·2	3	(1)
— —	15 45 2·73	15	113 31 31·3	5	(2)

(Set 1.) The planet and star were too close for the bisection to be made at time of right ascension measure. They were consequently taken alternately, and the north polar distance measures have been reduced to the time of the right ascension measures by the tabular hourly motion.

HYGEIA.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1850.	Greenwich M.T.	R.A.	N.P.D.	Comp^{d}—Obs^{d}. R.A.	N.P.D.
	h m s	h m s	° ′ ″	s	″
July 17	13 3 19·3	19 11 13·82	112 16 29·2	−9·93	+133·4
18	11 52 43·5	19 10 26·88	112 16 42·5	−10·02	+132·5
19	11 32 2·1	19 9 38·93	112 16 53·5	−10·32	+132·8
20	12 19 8·3	19 8 49·21	112 17 1·7	−10·61	+134·8

The observed places are corrected for refraction and parallax. The computed places were deduced from the ephemeris of M. d'Arrest, published in the *Monthly Notices*, vol. x. No. 7. It is supposed that the ephemeris is *not* corrected for aberration. It is also supposed that 10′ should be added to the R.A. of July 21, 23, and 25.

The star of comparison for all the observations is π *Sagittarii*. The following is the assumed place derived from the Greenwich Twelve-year Catalogue.

For 1850·0.

Mean R.A.	Mean N.P.D.
h m s	° ′ ″
19 0 50·33	111 15 24·25

NEPTUNE.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

	Greenwich M.T.	R.A.	N.P.D.	Comp^{d}—Obs^{d}. R.A.	Comp^{d}—Obs^{d}. N.P.D.
1850.	h m s	h m s	° ′ ″	s	″
August 3	12 56 27·1	22 33 27·44	99 56 15·2	+0·29	−0·6
5	11 52 29·6	33 16·76	57 21·3	0·23	0·8
6	12 6 27·7	22 33 11·17	99 57 55·7	+0·20	−0·7

The observed places are corrected for refraction and parallax.

The computed places were deduced from Mr. Sears C. Walker's ephemeris, published in the *Astronomische Nachrichten*, No. 721.

The stars of comparison on each day were B.A.C. 7840 and 7970. The following assumed places for 1850·0 are derived from the Greenwich Twelve-year Catalogue.

	Mean R.A.	Mean N.P.D.
	h m s	° ′ ″
B.A.C. 7840	22 22 42·20	101 26 37·2
— 7970	22 44 47·11	98 92 34·7

FLORA.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

	Greenwich M.T.	R.A.	N.P.D.	Star of Comparison.
1850.	h m s	h m s	° ′ ″	
August 6	13 16 40·2	0 35 34·15	94 37 38·45	B.A.C. 145
	13 36 37·8	34·60	41·08	— —
	13 56 35·4	34·98	43·98	— —
	14 16 32·8	0 35 35·39	94 37 45·14	— —

Corrected for refraction and parallax. Log Δ taken from supplement to *Nautical Almanac* 1853.

Assumed place of star of comparison for 1850·0, derived from the Greenwich Twelve-year Catalogue.

	Mean R.A.	Mean N.P.D.
	h m s	° ′ ″
B.A.C. 145	0 27 31·67	94 25 9·76

PETERSEN'S THIRD COMET.

Washington, U.S. Equatoreal. (Lieut. M. F. Maury.)

1850.	M.T. Washington. h m s	Comet.—Star. R.A. m s	Dec. ′ ″	Star of Comp.	No.	Obs.
June 3	10 15 58·7	+7 0·86	+11 45·85	Groombridge	2418	5
	.....	6 5·57	4 57·32	—	2420	5
4	9 59 45·4	3 52·81	+ 2 12·00	—	2411	10
5	10 16 45·1	+3 49·28	−12 51·61	—	—	10

Apparent places of stars of comparison on days of observation.

	R.A. h m s	N. Decl. ° ′ ″
Groombridge 2411	16 59 21·32	73 21 15·99
—— 2412	17 3 37·86	73 24 16·78
—— 2420	17 4 33·24	73 31 6·89

The place of 2411 is from the Radcliffe Observations, 2418 and 2420 from observation with mural and meridian circle.

The observations are not corrected for refraction or parallax.

Haverhill. (Mr. W. W. Boreham.)

1850.	Greenwich M.T. h m s	R.A. h m s		N.P.D. ° ′ ″		Stars of Comparison.
June 21	10 40 50	15 5 54·61	+p 0·037	26 57 11·1	+p 0·142	Arg. Z. 110, No. 12 and g.
22	10 55 44	15 0 28·72	0·043	28 6 0·8	0·100	— 108, No. 66.
23	10 56 46	14 55 15·61	0·045	29 18 53·5	0·067	B.A.C. 4967.
24	10 55 27	50 12·34	0·045	30 36 14·4	+p 0·037	— 4918.
27	11 28 48	36 14·68	0·054	34 59 56·6	−p 0·122	Arg. Z. 5, No. 3.
29	10 37 32	28 12·30	0·043	38 18 39·4	0·126	— 1, No. 21.
July 1	10 10 37	20 40·81	0·038	42 0 0·1	0·172	— 113, No. 33.
2	10 56 52	17 2·68	0·045	44 6 44·7	0·268	— 111, No. 59.
5	10 20 7	7 19·38	0·047	50 40 39·8	0·175	Groomb. 2097, Rad. Obs.
7	10 14 28	14 1 27·80	0·038	55 35 19·6	0·463	H.C. 25975.
11	11 4 28	13 51 1·72	0·041	66 30 28·3	0·636	— 25637.
13	10 54 10	46 31·29	0·040	72 12 15·4	0·681	B.A.C. 4634.
15	9 54 26	13 42 18·70	+p 0·039	77 57 23·7	−p 0·701	Weisse xiii. 752.

Professor Smyth of the Royal Observatory, Edinburgh, has kindly observed the star H.C. 33239, 33244, and gives its mean place 1850·48, R.A. $17^h\ 55^m\ 50^s{\cdot}68$; N.P.D. $15°\ 24'\ 29''{\cdot}1$, a small correction will therefore be required to be applied to my observation of May 28.

The observation of June 11, given in the previous number, should stand thus, N.P.D. $19°\ 6'\ 8''{\cdot}1 + p\ 0{\cdot}306$.

June 21 : g is the star compared with; this precedes Arg. Z. 110, No. 112, $1^m\ 46^s{\cdot}35$, and is north of it $3'\ 17''{\cdot}1$.

All the observations after July 2 are corrected for refraction, before this date the position of the comet rendered the correction inappreciable.

DURHAM. Fraunhofer Equatoreal. (Mr. R. C. Carrington.)

1850.	Greenwich M.T. h m s	R.A. h m s	s	N.P.D. ° ′ ″	″	Set.
June 4	11 54 21·6	17 4 17·71	−0·014 *p*	16 34 20·0	+0·319 *p*	(8)
7	13 24 19·6	16 40 45·73	+0·055 *p*	17 26 11·7	0·255 *p*	(9)
13	12 23 55·6	15 56 19·92	0·051 *p*	20 15 6·2	0·201 *p*	(10)
15	12 19 10·0	42 25·91	0·055 *p*	21 35 0·1	+0·159 *p*	(11)
19	13 17 29·5	16 45·35	0·076 *p*	24 59 33·4	−0·055 *p*	(12)
20	12 28 2·5	15 11 8·07	0·064 *p*	25 57 43·5	+0·002 *p*	(13)
22	12 38 30·3	14 59 33·44	0·066 *p*	28 11 8·0	−0·085 *p*	(14)
24	12 47 12·5	49 50·68	0·066 *p*	30 42 23·8	0·171 *p*	(15)
	13 21 27·5	49 43·96	0·071 *p*	44 13·9	0·240 *p*	(16)
26	13 43 11·2	40 18·33	0·068 *p*	33 36 20·6	0·358 *p*	(17)
27	13 28 36·2	35 58·07	0·065 *p*	35 8 29·1	0·365 *p*	(18)
28	13 49 9·2	31 42·12	0·064 *p*	36 48 26·7	0·444 *p*	(19)
29	12 46 1·4	27 51·44	0·059 *p*	38 27 55·7	0·357 *p*	(20)
July 1	12 43 31·7	20 19·18	0·055 *p*	42 12 12·4	0·427 *p*	(21)
3	11 25 6·7	13 33·60	0·045 *p*	46 14 50·9	0·374 *p*	(22)
4	11 35 25·9	10 18·23	0·046 *p*	48 29 2·7	0·431 *p*	(23)
5	11 45 51·6	14 7 7·19	0·046 *p*	50 49 22·8	0·486 *p*	(24)
9	10 56 32·7	13 56 0·41	0·039 *p*	60 55 59·3	0·575 *p*	(25)
10	13 31 18·1	53 11·96	0·042 *p*	63 58 52·5	0·781 *p*	(26)
13	11 57 54·8	46 22·52	0·040 *p*	72 21 46·0	0·753 *p*	(27)
15	11 20 36·1	13 42 11·83	+0·038 *p*	78 8 7·4	−0·786 *p*	(28)

Stars of Comparison.	Assumed Apparent Places. R.A. h m s	N.P.D. ° ′ ″	No. of Diffs. obsd. R.A.	N.P.D.	Set.
B.A.C. 5769	16 59 21·63	16 38 44·1	5	1	(8)
Argelander, Zone 124, No. 17	16 38 42·14	17 19 42·8	3	1	(9)
—— 116, No. 133	15 54 24·98	20 6 4·1	6	6	(10)
Unknown. See Notes.	15 44 40·16	21 22 18·3	19	4	(11)
—— ——	15 6 16·21	24 52 44·5	10	2	(12)
Argelander, Zone 112, No. 91	15 9 8·29	25 48 41·2	23	5	(13)
—— 108, Mean of Nos. 64 and 66	14 55 23·09	28 18 18·2	15	3	(14)
Unknown. See Notes.	14 45 51·20	30 32 51·1	25	5	(15)
Perhaps Arg. Zone 7, No. 26. See Notes.	14 53 30·46	30 51 55·0	9	2	(16)
Argelander, Zone 5, No. 29	14 35 5·75	33 38 44·9	15	3	(17)
B.A.C. 4845	14 33 31·25	35 19 23·2	30	6	(18)
Unknown. See Notes.	14 36 30·12	36 42 19·6	10	2	(19)
Argelander, Zone 1, No. 22	14 26 42·14	38 18 41·1	28	6	(20)
—— 113, No. 33	14 23 26·42	42 9 46·5	32	7	(21)
Unknown. See Notes.	14 16 39·74	46 6 2·6	25	5	(22)
—— ——	14 17 44·50	48 28 9·0	23	5	(23)
Lalande 25924	14 0 8·09	50 51 43·0	28	6	(24)
— 25780	13 54 33·94	60 51 39·5	40	8	(25)
— 25610	13 47 29·88	64 3 0·5	12	3	(26)
B.A.C. 4634	13 45 21·09	72 31 16·5	30	8	(27)
Unknown. See Notes.	13 46 34·95	78 11 36·7	15	5	(28)

Since the 4th of June a wire micrometer with 5 transit wires and 2 moveable declination wires has been used; previously a bar-micrometer. A succession of sea-fogs and cloudy weather prevented following the comet further. The observations are corrected for refraction. The factors for parallax are given, p being the E. H. parallax in *arc* in both cases. It will be understood that the places of the stars mentioned below are only roughly approximate. Whatever correction may be found to be required by the star must be applied to the comet. Most of the Argelander-stars have been checked by comparison with one or more neighbouring stars.

(Set 9.) The star was not identified on the night of observation, the weather not allowing time.

(10.) Taken on a boisterous night by the help of a hearing tube; the telescope somewhat in vibration.

(11.) The star was the first preceding of a group of five. The second followed in $1^m\ 13^s{\cdot}6$, and was Argelander Z. 116, No. 124.

(12.) The star was preceded by another by 70^s, and by $10'{\cdot}5$ more N. Its place depends on Argelander Z. 112, Nos. 82 and 83.

(14.) Mean taken. The two places in Argelander very discordant.

(15.) The star was preceded by another by $1^m\ 23^s{\cdot}2$, and by $5'{\cdot}0$ more N. Its place depends on Argelander Z. 7, Nos. 11 and 15.

(16.) The star's place depends on Argelander Z. 7, Nos. 21, 23, and 28. It was the s. p. star of an open double; both of 9·10th magnitude. I could not recognise Argelander Z. 7, No. 26; probably it was the star used, its declination being supposed 40″ in error.

(18.) The minutes of declination of Argelander Z. 5, No. 26, should be 42′, not 32′; it is then B.A.C. 4845, the star used.

(19.) The star was of 8th magnitude; its place depends on Argelander Z. 1, No. 38.

(22.) Star depends on Lalande 26358. No. 26582 appears to be about 50^s in error: right ascension *too great* by that amount.

(23.) The star's place depends on Lalande 25937, and through intermediate stars on B.A.C. 4728. Lalande 26041 appears to be 35^s erroneous in right ascension.

(24.) Lalande 25924 and 25925 are identical; the decimal point of the seconds of north polar distance of the latter is misplaced. The mean right ascension of the two appears nearly 2^s too great. Before adopting the above place, I compared the star with B.A.C. 4783, and γ *Boötis*.

(28.) The star is neither in Bessel or Weisse; it was of 9th magnitude; its place depends on Weisse XIII., Nos. 824 and 995.

Size of the Comet, observed at Durham.

"The state of the atmosphere being very favourable on June 29, a few measures of the extreme diameter of the nebulosity of the comet in the north and south direction were made. The mean result was $2'\ 6''{\cdot}3$ on June 29, at $12^h\ 54^m$ Green. M.T.

"This, reduced approximately by the value of log Δ given in D'Arrest's Ephemeris, makes the total diameter of the comet in this direction a little more than four times that of the earth. So far as I could get any impression of the comet's form, I should say it was somewhat elongated in the south-south-following direction, but this was doubtful.

"This was the only night at Durham on which the comet appeared backed by a dark ground: on all other occasions the nebulosity shaded off into the white vapour in the sky. Single measures of the size were made also on June 24 and July 9. They give values a little less than the one above, as was to be expected for the reason stated."

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1850.	Greenwich M.T. h m s	R.A. h m s	N.P.D. ° ′ ″	Star of Comp.
June 22	12 27 53·1	15 0 7·12	28 10 36·8	5097 B.A.C.
26	12 15 35·7	14 40 35·84	33 30 44·6	θ Boötis

The values of the factors for parallax are,—

June 22 $\log \frac{p}{P} = +8{\cdot}8071$ $\log \frac{q}{P} = -8{\cdot}4356$

26 $= +8{\cdot}7720$ $= -9{\cdot}1956$

July 4	10 58 2·2	14 10 22·60	48 25 30·2	4812 B.A.C.
7	12 0 56·5	14 1 16·73	55 46 27·9	4808 —
9	12 27 34·0	13 55 51·52	61 6 14·8	4640 —
13	12 17 22·8	13 46 19·63	72 24 8·7	4597 —
14	11 57 52·7	13 44 14·25	75 16 54·2	(*a*)
16	10 28 38·2	13 40 16·95	80 56 42·4	(*b*)
18	10 43 1·3	13 36 28·36	86 49 9·4	4529 B.A.C.
19	10 34 20·7	13 34 41·56	89 32 10·3	4532 —

The observations in July are corrected for parallax.

The log Δ is taken from M. Sonntag's ephemeris, published in the *Monthly Notices*, vol. x. No. 7.

The following are the assumed places of the stars of comparison for 1850·0.

	Mean R.A. h m s	Mean N.P.D. ° ′ ″	Authority.
B.A.C. 5097	15 21 35·96	30 30 24·76	Green. 12-year Cat.
θ Böotis	14 20 5·30	37 27 15·15	— — —
B.A.C. 4812	14 26 2·20	51 2 0·72	— — —
— 4808	14 25 21·85	58 58 4·24	— — —
— 4640	13 46 22·25	60 36 45·90	B.A.C.
— 4597	13 40 8·04	71 47 36·96	Green. 12-year Cat.
(*a*)	13 48 36·51	75 12 24·81	Compd with 1086, 1147 of Green. 12-year Cat.
(*b*)	13 42 17·42	80 50 38 48	
B.A.C. 4529	13 26 31·87	85 34 7·70	Green. 12-year Cat.
— 4532	13 27 3·25	89 49 38·07	— — —

Elements of Petersen's Third Comet. Calculated by Dr. Petersen and M. Richard Schumacher, May 4, June 6, July 9.

T. 1850, July 23·52220 Greenwich M.T.

	° ′ ″	
π	273 24 20·5	Mean Eq. 1850·0.
Ω	92 53 1·5	
i	68 12 12·5	
Log. *q*	0·0340197	

Direct.

"It has been impossible to represent the middle observation closer than to 7″ in longitude and latitude, but the difference is too small to warrant the conclusion that this is a sign of ellipticity."

Ephemeris of Petersen's Comet for 0^h *M.T. Berlin.**
By M. R. Schumacher.

	R.A.	S. Decl.	Log. Δ.	Log. *r*.
	° ′	° ′		
Sept. 21	194 46	68 44	0·1545	0·1594
25	195 16	70 34	0·1712	0·1715
29	195 56	72 23	0·1869	0·1837
Oct. 3	196 48	74 11	0·2015	0·1957
7	197 50	75 59	0·2153	0·2076
11	199 9	77 47	0·2282	0·2194
15	200 52	79 35	0·2405	0·2310
19	203 9	81 24	0·2522	0·2424
23	206 28	83 13	0·2634	0·2536
27	211 54	85 2	0·2740	0·2646
31	222 48	86 47	0·2843	0·2753

On a Method of finding the Effect of the Difference of Parallax, at different Places, upon the Time of Disappearance and Reappearance of a Star occulted by the Moon. By the Rev. Temple Chevallier.

The author treats the theory of occultations by supposing a line to be drawn from the centre of the earth to the star, and drawing a plane perpendicular to this line, and projecting upon this plane the disk of the moon and the place of the point of observation on the earth at the instant of disappearance or reappearance at one station: the position of the place being defined by rectangular co-ordinates, and the form of the projection of disk being defined by an equation between rectangular co-ordinates. At the station for which the occultation has been computed the co-ordinates satisfy that equation, or the projection of that station is on the circumference of the circle which is the projection of the moon. For another station the projection is not on the circumference of the circle, and the difference of the absolute times of occultation will depend on the distance of its projection from the circle. The author then has recourse to a graphical method: he lays down, by means of the elements in the *Nautical Almanac*, the places of the star on the moon's limb at disappearance and reappearance; by applying to these the computed differences of projections of the two stations, he obtains the apparent positions of the star at the same instants, as seen from the other station; then joining these by a straight line, and assuming that the apparent path of the star will

* An ephemeris for the same time, but with earlier elements, was calculated by M. Sonntag, and sent some weeks ago by Professor Schumacher to the Astronomer Royal for Mr. Maclear's use.

be in that line, and will be described with a uniform velocity such as would carry it between the *Nautical Almanac* places of disappearance and reappearance in the *Nautical Almanac* duration, those parts of the straight line which are intercepted between the apparent positions of the star and the moon's limb serve for measures (approximately) of the time which must yet elapse before the phenomenon takes place, or which has elapsed since it took place, at the second station.

On a Graphical Mode of Computing the Excentric Anomaly.

By J. J. Waterston, Esq.

The equation expressing the relation between excentricity (e), the mean anomaly φ, and the difference between the mean and excentric anomalies x, being $x = e \sin(\varphi + x)$, or $\sin(\varphi + x) = \frac{1}{e} \cdot x$, Mr. Waterston graphically solves this equation by means of the curve of sines.

Having drawn this curve, the unknown ordinate is evidently a known multiple $\left(\frac{1}{e}\right)$ of the difference between the known abscissa (φ) and the unknown abscissa ($\varphi + x$). Hence it is found by drawing a line from the extremity of φ inclined to the axis at an angle whose tangent is $\frac{1}{e}$.

The accuracy with which the value of $\varphi + x$ is determined will depend on the accuracy with which the curve is drawn, and also upon the scale to which it is drawn. If the radius be 8 inches it can with ease be read off to within 5′.

When a value of x has been obtained from the scale, it can be corrected by computation. Thus, since

$$e = \frac{x}{\sin(\varphi + x)},$$

if the approximate value of x, determined from the scale, be substituted, an error of e will be obtained, and the corresponding error of x will be found by differentiating the equation with regard to x.

The author shows also how this correction may be obtained by a simple construction, and how the method of graphical projection may be applied conveniently in extreme cases, when the mean anomaly is small and the excentricity great.

A diagram is annexed, exhibiting the curve and scales, with the construction for a given case.

On the Limits of Error in the Elements of the Orbit of α Centauri, and on the Orbits of p Eridani and 61 Cygni. By Capt. W. S. Jacob, Astronomer at Madras. Communicated by Professor Piazzi Smyth.

The substance of these communications was received by Professor Smyth from Captain Jacob, in a series of private letters; and he has thought them of sufficient importance to induce him to collect together the results of the observations and deductions, and to present them to the Society.

α Centauri.

From observations, necessarily rough, made at Madras, Captain Jacob finds for *α Centauri*, for the epoch 1849·63, the distance of the components 36″·23, and the angle of position 244°·5, which renders probable a later perihelion passage, a less excentricity, and a less inclination, than had been previously assigned by him.

On examining all the observations of *α Centauri*, available for the purpose between the years 1825 and 1849, the conclusion seems to be, that the annual motion in area is about two square seconds; but, on carrying this back to 1750, it cannot be accommodated to any ellipse whatever, so as to give a distance not exceeding 25″, and a position in the south preceding quadrant, unless a revolution be supposed to intervene.

The period is, therefore, limited to between 75 and 80 years, two revolutions in the interval being inadmissible; and the area of the apparent ellipse is thus limited to 150″ or 160″. This being assumed, it is found that the greatest possible value of the minimum distance is about 2″·5, and the latest possible time of nearest approach is 1854.

With regard to mass, the least possible value of the true semi-major axis is about 11″·5, which corresponds to a mass of about 0·325; the excentricity being, however, indeterminate, the inclination and major axis may be very great. On the whole, the mass cannot differ very widely from that of the sun.

Captain Jacob has been enabled to arrive at some conclusion with regard to the quantity of light emitted by *α Centauri*, from photometrical considerations by means of experiments on the distances at which the flashes from a heliotrope were visible with different apertures, made during his employment on the Trigonometrical Survey.

He found, after several years' observations, that for apertures of 0·5, 1, 2, 4, and 8 inches, the limits of distance ultimately resulted 15, 23, 33, 45, and 60 miles respectively.

This gives a rate of absorption which agrees pretty well with Professor Forbes' results given in the *Phil. Trans. for* 1842, vol. ii.

Applying these results to the intensity of solar light, the diameter of the object that shall be about as bright as *Venus*, is 0·0205 inch per mile, or subtends an arc of 0″·0668. Making also due allowance for the circumstance that the object viewed was the reflexion of the sun from a metallic surface after passing twice through glass,

and assuming that the mean altitude of the sun for the times of observation may be taken to be about 23°, the portion of the zenith seen equal in brightness to *Venus* is 0·035.

Assuming also that the brightness of *Venus* is four times as great as that of *Sirius*, and that of *Sirius* four times as great as that of *α Centauri*, the brightness of *α Centauri* will be equivalent to a circular area of the sun's disk, whose diameter subtends an angle of 0″·009, or the sun must be removed to 213333 times its present distance to have a brightness equal to that of *α Centauri*. Its parallax must, therefore, be 0″·97.

Captain Jacob earnestly recommends astronomers who have *α Centauri* above their horizon to lose no time in commencing observations upon it.

Orbit of p Eridani.

This star is one of the quick-moving double stars, but the data are rather anomalous. All the observations found by Capt. Jacob are,—

		Position	Dist.
Dunlop	1825·96	16° 54′	2″·5
Herschel	1835·0	— 122 18	— 3·65
Jacob	1845·88	— 186 0	— 4·16
—	1846·83	— 277 0	— 4·32
—	1849·82	— 270 0	

Herschel's position should probably be 302° 18′, and the first of Jacob's observations should, doubtless, have 90° added.

Captain Jacob computes an orbit from the above observations, of which the elements are,—

a = 5″·37
e = 0·454
π = 1° 30′
Ω = 295 27
γ = 57 24
P = 123 yrs.
τ = 1827·08

but finding that these elements would give the distances of the stars for Dunlop's epoch only 1″·56 instead of 2″·50, an error quite inadmissible, as the stars would then not have been separable by the telescope used, he assumes an error in Dunlop's position, and presumes that this should be 163° 6′ or 343° 6′.

On this supposition, the following elements of the orbit result:—

a = 4″·25
e = 0·323
π = 36° 30′
Ω = 290 40
γ = 46 36
P = 107 yrs.
τ = 1819·83

61 Cygni.

Captain Jacob supposes that this star will arrive at a minimum distance of 17″ or 17″·5 within the next 30 years; that the period is about 660 years; and that $a = 21''$ or $22''$, and $e =$ about 0·25, the mass being not much inferior to that of the sun.

Proper Motion of B.A.C. 535. By Mr. Johnson.

In comparing the results of the Oxford Observations with those of other catalogues, the true proper motion of this star has been detected:—

Right Ascension.

B. A. C. 535 = B. F. 203 = P. I, 159 = Groombridge 376 = Taylor 571 = Greenwich 12-Year, 150.

		R.A. =	h	m	s	Prec. =
Piazzi	1800		1	33	26·20	+4·104
Groombridge	1810			34	8·02	4·114
Taylor	1835			35	54·22	4·138
Greenwich	1845			36	36·12	4·147
Oxford	1845	=	1	36	36·05	4·147
—	1850			.....		+4·152

The above reduced to 1850 by the Prec. due to the middle period, become

		R.A. =	h	m	s
Piazzi	1850		1	36	52·60
Groombridge	—				53·34
Taylor	—				56·40
Greenwich	—				56·87
Oxford	—	=	1	36	56·80

The mean epoch of the observations on which the Greenwich R.A. depends is 1843. The Oxford epoch is 1844. These R.A. compared with Piazzi's give an Annual Proper Motion = +0ˢ·0974.

Applying the correction +0ˢ·0974 (1850 − t), t being the epoch of the respective catalogues, we have

		R.A. =	h	m	s
Piazzi	1850		1	36	57·47
Groombridge	—				57·24
Taylor	—				57·86
Greenwich	—				57·55
Oxford	—	=	1	36	57·38

The mean of the above is 1ʰ 36ᵐ 57ˢ·50. The R.A. of B.A.C. is 1ʰ 36ᵐ 52ˢ·95.

Mr. Baily supposed that there was a mistake of one year's precession in Mr. Taylor's R.A. He was led to this supposition, apparently, by a mistake in the Madras catalogue, where the proper motion in R.A. is given = 0ˢ·009, instead of 0ˢ·09.

North Polar Distance.

		N.P.D.	Prec.		N.P.D.
		° ′ ″	″		
Piazzi	1800	= 27 8 32·7	−18·41	1850	= 26 53 15·2
Groomb.	1810	27 5 31·2	18·39	—	17·6
Taylor	1835	26 57 56·9	18·33	—	25·5
Greenw.	1845	26 54 55·8	18·30	—	24·3
Oxford	1845	= 26 54 56·7	18·30	—	= 26 53 25·2
—	1850	.....	−18·29		

The mean epoch of the Greenwich observations is 1843. The Oxford epoch is also 1843. Comparing these N.P.D. with Piazzi's, there appears to be an Annual Proper Motion in N.P.D. = +0″·22.

Correcting the above N.P.D. for 1850 by +0″·22 (1850 − t), we have

Piazzi	1850	N.P.D. =	° ′ ″ 26 53 26·2
Groombridge	—		26·4
Taylor	—		25·5
Greenwich	—		25·8
Oxford	—		26 53 26·7

The Madras Catalogue makes the Proper Motion in N.P.D. = +0″·19
The B.A.C. ,, ,, = +0″·14

Letter from Lord Wrottesley.

"On the 1st of January last, I commenced observing a new catalogue of the right ascensions of small stars, selected from the B.A.C. The catalogue, when complete, will contain above 1000 stars of the 6th and 7th magnitudes, chosen from among those which have either great proper motion or have been inadequately observed. It is a curious coincidence that the Madras Observatory, which was before engaged contemporaneously with myself on a similar task, has again entered upon the same field of inquiry; and I cannot do better than imitate the example of the Madras Astronomer, by communicating to the Royal Astronomical Society from time to time those stars whose places differ materially from the catalogue already referred to.

"In all these cases, care has been taken to search diligently for the true star; but none could be found nearer to the place given in the catalogue. It is my intention to observe each star at least five times, and therefore it will be understood that the observations of some of the objects in the accompanying list are not yet finished.

"The observations are made with the 5-foot transit and clock described in the tenth volume of the *Royal Astronomical Society's Memoirs*, set up in a fixed observatory, the place of which is given in the *Nautical Almanac for* 1852, *et seq.*; but the detailed description of which I may postpone till the catalogue is completed."

List of Stars in the B. A. Catalogue already observed, in which the Right Ascension differs by more than One Second in Time from that Catalogue.

B.A.C.	Excess of Observed Mean Place above B.A.C. s	No. of Obs.	B.A.C.	Excess of Observed Mean Place above B.A.C. s	No. of Obs.
1826	+ 1·16	6	4652	+28·97	5
1907	− 5·18	7	4682	+ 1·21	5
2070	− 1·06	2	4723	− 1·43	5
2488	+ 1·30	3	4776	− 1·34	5
3086	− 1·55	2	4920	− 1·34	4
3233	−60·71	2	5091	− 1·02	4
3627	+ 1·46	5	5527	+ 1·87	2
4199	+ 1·63	5			

Micrometrical Measurements of Double Stars, made at Ormskirk between 1834·0 *and* 1839·4. By W. R. Dawes.

"The observations which I have now the honour of presenting to the Society were made partly with the 5-foot equatoreally-mounted achromatic telescope employed in procuring the results published in the eighth volume of the *Memoirs*, and partly with a Newtonian reflector having a focus of about seven feet and an aperture of six and a quarter inches. The large mirror and the small plane mirror of this telescope were presented to me by Sir John Herschel during my visit to him at Slough in the autumn of 1833, previous to his departure for the Cape of Good Hope. These metals were mounted for me by Mr. Dollond, so as to be applied to the polar axis of my 5-foot achromatic, and to supply the place of the counterpoise to the telescope and declination-circle in that mounting. The motion in polar distance was produced by means of two brass circles, about two feet in diameter, one of which was firmly attached to the polar axis, and the other to the tube of the reflector; the circles being united at their centres, and fixable by a clamp at any required polar distance. A small setting-circle with a level was attached to the outer side of the tube, whose vernier read to one minute. This mounting was found to be sufficiently steady, in tolerably calm weather, to allow of satisfactory measures with the micrometer; and, as far as I know, it was the *first* successful attempt to give to a Newtonian reflector a universal equatoreal motion suitable to the delicate micrometrical measurements of double stars.

"The large metal was cast and originally figured by Sir William Herschel; but the surface having become greatly tarnished, it was repolished by Sir John, shortly before he presented it to me. Its figure was sufficiently good to give a neat round disk to a star; and from its *larger aperture*, its *separating* power

considerably exceeded that of the 5-foot achromatic: so that on tolerably bright and very close double stars, such as γ *Virginis* at that period, and λ *Ophiuchi* (then much closer than at present), its superiority was unquestionable. Unfortunately, it soon lost so large a portion of its lustre that its illuminating power became inferior to that of the 5-foot refractor. It was also much less certain and uniform in its action, though a great variety of expedients were resorted to in hopes of overcoming this annoying defect; some of which were productive of advantage, though not to the extent of rendering it as uniform in its action as the refractor. By Sir John Herschel's recommendation it was bedded in its box on folds of flannel, the edge of the metal also resting on the same soft and elastic substance. The effect of friction on its edge being, however, still too obvious, I substituted for the flannel a piece of strong tape, supporting the metal as in a sling, and permitting it without obstruction to take an equal bearing against the flannel at the back. This I found to be a decided improvement; and Mr. Lassell, having recently adopted a similar plan in the mounting of his 9-inch and 24-inch metals, also bears testimony to its great utility. As, however, a telescope requires for its perfect action that the state of the air should be good in a degree proportioned to the area of the object-glass or metal, vision was usually, on most objects, best in the refractor; and even in the finest states of the atmosphere the reflector did not always answer the reasonable expectations of the observer; and much precious starlight was frequently lost in vain attempts either to discover or remove the cause of its distress. This circumstance, combined with its rapid loss of lustre, caused the reflector to be but little employed during the latter part of the period embraced by these observations.

"In the measurement of very minute stars, the achromatic concave lens, mentioned in my former communication, has been very generally employed. As the construction and use of this valuable appendage has not, I believe, been described in any paper presented to this Society, it may be proper to refer to it here more particularly. The lens is fully described in a paper by Mr. Dollond, which was read before the Royal Society in February 1834; into which paper were introduced a letter from myself to Mr. Dollond, stating the advantages of its application to the micrometer, and also a letter to Mr. Dollond from Professor Barlow, the *inventor* of the lens, detailing the formulæ according to which it was constructed. Mr. Dollond says in the paper alluded to, 'I do not wish to take credit to myself for anything like an invention, but merely for the application of the lens to the micrometer, as I am fully convinced that a concave lens, either simple or achromatic, was never so applied before.' In referring to this achromatic concave lens, in the notes appended to these observations, I have therefore termed it '*the* Barlow *lens*,' by which name justice is done to its inventor. In Mr. Dollond's valuable application of it to micrometrical purposes, it is introduced, by the tube in which it is mounted, into the main tube of the telescope, so as to intercept

the rays transmitted by the object-glass before they come to focus. The focal image is thrown a few inches further from the object-glass than it otherwise would be, and it is proportionably *enlarged*. By a variation of the distance between the object-glass and the Barlow lens, the degree of enlargement is altered; and thus that amplification of the image can be fixed upon which best suits the purpose of the observer. The lens Mr. Dollond constructed for me was mounted in a piece of tube, of such a length that when screwed into the telescope it rather more than doubled the diameter of the focal image: and this proportion appeared to be generally the most useful.

"The advantages attending the use of the Barlow-lens may be *comparatively* summed up as follows:—

"1. The diameter of the micrometer-threads subtends only about half the angle: small stars are, therefore, neither obliterated nor distorted by them.

"2. The moveable parallel threads are *both as nearly in focus*, with double the magnifying power. This is a most important matter in the measurement of distance. As the parallel spider's lines must pass each other freely, they must move in different planes, and at different distances from the eye-piece. Consequently, when high powers are produced in the ordinary way on a telescope of the usual proportions (the power being, for instance, more than five or six times the focal length, expressed in inches), there is an obvious indistinctness in one of the threads when the other is accurately in focus. This defect is nearly got rid of by the use of the Barlow-lens.

"3. The value of the micrometer divisions with the Barlow-lens is only about half of its amount without it; permitting a proportionably fine motion in the measurement of distance.

"4. With any given magnifying power, the threads are distinct to a much greater distance from the centre of the field; the eye-piece producing the power having double the focal length.

"5. The eye-pieces of greater focal length are much more easily cleaned than those of less; of great importance in high powers especially.

"6. The small reflecting *prism* interposed between the eye-piece and the eye can be advantageously employed with double the magnifying power on the telescope. This extension of its utility is of great value.

"As a set-off against the important advantages above enumerated, it must be acknowledged that the application of the lens increases the length of the telescope by a few inches, and also that it is requisite to determine the value of the micrometer-screw with the lens attached to the telescope, as well as without it. Neither of these objections, however, is of much practical importance. One of more weight is the greater illumination of the field, which is requisite to render the very fine spider's lines sufficiently visible. For this, the most efficient remedy (in addition to the *deep red* illumination) is an increase of magnifying power. By this means the apparent diameter of the threads is augmented *in proportion to the power*,

while the brightness of the field is *diminished* in the *duplicate ratio* of the increase of power. It is important to notice that the brilliancy or vividness of a *fixed star* is *not* diminished in the same proportion, though it is usually assumed to be so. To an object of sensible diameter, as a planet, such reasoning is applicable, but not to a fixed star, the apparent diameter of whose telescopic disk is *not* increased *in proportion to the power employed.*

"The spider's lines, when thus attenuated by the use of the Barlow-lens, are too fine for use in observing angles of position; my own eye, at least, is dissatisfied with them, as not possessing sufficient substance for the judgment to lean upon. I, therefore, had two pretty thick parallel metallic wires fixed into the micrometer-plate, which formerly held a single spider's line at right angles to the moveable parallel threads, and intended for measures of position. The diameter of each wire subtended an angle of about 4″, and the inner edges were placed about 7″ or 8″ apart. Their visibility with feeble illumination of the field extended the power of the telescope, in measuring angles of position, to stars of fully one magnitude lower. Their perfect parallelism was proved by stars rolling along the inner edge of both with the same setting of the position-circle.

"In the *Introduction* to my former double-star observations, I adverted to the importance of placing the stars parallel to a principal section of the eye; so that they should appear in the telescope nearly vertical or nearly horizontal. Further experience has even more fully convinced me of the necessity for this. When the obliquity of the star's position is not more than 20° or 30°, a corresponding inclination of the observer's head may answer the purpose without introducing an inconvenient posture. When, however, the angle of position lies between 30° and 60° from the meridian, the use of the reflecting prism attached to the eye-piece renders it easy to adapt the apparent position of the stars to the observer's convenience. By the help of this valuable little appendage, many of the stars in the following catalogue were observed both in an apparently vertical and horizontal position, in order, as much as possible, to destroy all bias of the judgment."

We have selected from Mr. Dawes' paper some notices of remarkable stars.

γ Ceti. Σ 299. Mr. Dawes gives the angles of positions by several observers, and considers that the agreement between the angles of the same observer, and the discrepancies between different observers, seem to show somewhat of a *personal equation.* The observations make the binary character of the star probable, but do not prove it to be so indubitably.

Castor. Σ 1110. "My observations of this star since 1833 do not confirm the orbit predicted by Sir John Herschel (*Mem. Ast. Soc.* vol. v. p. 203). The distance is still increasing, and is now fully 5″."

γ Virginis. Σ 1670. "The angle I obtained in 1834 being the result of eight nights' observation is probably entitled to some consideration, although the distance was only about 0″·9."

44 *Boötis.* Σ 1909. "The observations of this star show a continued augmentation of the distance, with a very slight increase in the angle of position."

ξ *Scorpii* (= ξ *Libræ* = 51 *Libræ*). Σ 1998. "The variation of the angle of position of these stars in a direct sense is supported by the observations given in the following catalogue. Combined with my observations for 1833 contained in my previous paper, we have,

1833·39	P = 6°·20	D = 1″·15	by 1 night's obs.
1834·50	7·12	1·166	— 4 — —
1836·49	9·53	...	— 1 — —

In the *Phil. Trans.* for 1785, the position is given by Herschel I. as 82° 2′ *north following*, or 7° 58′ in the notation now used. As, however, the stars are almost exactly equal, it seems highly probable that, to compare it with the more modern observations, the position should be increased by 180°. Instead, therefore, of a *whole* revolution having been performed since 1782, it is most likely that only about 197°·5 have been passed over. The apparent distance seems to have varied but little. The angle of position at the present time (1850) is about 31°."

Cephei 83. Σ 2751. "A diminution of distance in these stars is probable, while the variation in position, if any, is so small as to be completely masked by the errors of observation."

Pegasi 29. Σ 2804. "This object was supposed by Sir John Herschel to be in rather rapid rotation, from a comparison of his own measures with each other, and with those taken by Sir James South in 1826. It is remarkable that Struve arrived at the same conclusion from comparing together his own observations during six years, which show a pretty regular increase of nearly 5° in that time. The measures which I have obtained, however, do not bear out so rapid a motion, even if there be any; and Struve's re-examination of the star led him to reject the supposition of change. My observations at two different epochs are as follows:—

1832·87	P = 314°·17	D = 3″·12 by 1 night's obs.
1835·44	317°·00	3″·18 by 3 — —

"Notwithstanding the trouble which this star has already given, it is desirable that it should be still further examined, as it may be questioned whether its real nature is even yet determined."

ζ *Aquarii.* Σ 2909. "The retrograde motion of these stars is distinctly shown by the observations here recorded.

"A diminution of distance may be suspected, though it must be acknowledged that my earlier measures of distance were generally too large."

Σ 3061. "The change which Sir John Herschel suspected was going on in this star is by no means supported by my observations.

"It is worthy of remark that in this case, as in most others in which extraordinary changes of angle have been deduced from erroneous observations, the position of the stars is very *oblique* to the

meridian; and it is probable that, in the earlier measurements, no peculiar precautions were adopted on that account."

The catalogue then follows, and consists of 627 entries (many of these relate to the same star), containing the name of the star, Struve's number, the approximate right ascension and north polar distance for 1840, the angle of position and distance, with the number of observations, the weight of the result, and the magnifying powers employed. Finally, are set down the magnitudes of the component stars and the epoch at which the measures were made.

On the Longitude and Latitude of the Observatory, George Town College, near Washington, and the Situation of some Leading Points in that City. By Mr. Curley.

"The latitude of our Observatory is deduced from 7 observations of *Polaris* above and below pole, 7 observations of *α Ursæ Majoris* above and below pole, 7 observations of *λ Ursæ Minoris*, using the *Nautical Almanac* declination, and 180 observations of other stars. The mean of these accordant observations gives the latitude of George-Town College Observatory 38° 54′ 26″ North.

"The instrument with which the observations were made is a meridian transit circle by Simms, with a divided circle of 45 inches diameter, read off by four microscopes. The telescope is of 5 feet focus and 4 inches aperture. The nadir point was found by viewing the wires reflected from a surface of mercury.

"The longitude from Greenwich is deduced from four corresponding lunar transits made at Greenwich and George Town, with all the seven wires. The Astronomer Royal very kindly sent the observations immediately on request. There were more corresponding observations, but as some of the wires were wanting, and as the mean of seven wires from imperfect transits generally differs from the mean of seven wires observed, the perfect observations alone were employed. The transit instrument is by Ertel of Munich. The object-glass has a focal length of 6 feet, and the aperture is of 4·6 inches. The clock is a good one, by Molyneux of London.

"The computation was performed nearly in the manner recommended by Mr. Baily. Having got a good approximation to the longitude of George Town, the increase of the moon's right ascension between the two meridians was divided by the moon's hourly motion computed for the mean of the Greenwich times of observation. The result is, that the George-Town College Observatory is $5^h\ 8^m\ 18^s{\cdot}2$ West of Greenwich."

By a base of 957 feet, measured along the aqueduct leading the Chesapeak and Ohio Canal across the Potowmac, and a Munich universal instrument, which reads off horizontal angles to 10″, Mr. Curley found the distance between the National Observatory and the George-Town Observatory to be 8764·4 feet.

The direction of the National Observatory from the George-Town Observatory was observed to be 56° 44′ 40″ to the East of South. Hence, after allowing for the distance of the domes from the points of observation, the dome of the National Observatory is 47″·4 South and 6ˢ·2 East of the dome of George-Town College Observatory.

From Mr. Kluskey, City Surveyor of Washington, the following differences of latitude and departure between the dome of the Capitol and the National Observatory were obtained, viz.—

Capitol Dome 1906 feet S., and 12158·8 feet E. of the National Observatory.

Adopting the position of George-Town Observatory, given above, Mr. Curley finds the following latitudes and longitudes:—

	North Lat.	West Long.
	° ′ ″	h m s
George-Town College, Dome	38 54 26·0	5 8 18·20
National Observatory, Dome	53 38·58	12·00
Capitol — Dome	53 19·87	1·74
Old Naval Observatory, Lieut. Gilliss' Station	38 53 31·61	5 8 1·83

i.e. following Lieut. Gilliss' statement, that it was 1200 feet N.W. 5° from the Capitol Dome.

Mr. Curley adds that the substance of the above account is taken from a MS. written two or three years ago, which contains a description of the instruments and some observations. Circumstances have not permitted him to get the MS. printed.

On the Numerical Computation of the Values of Slowly-converging Series. By Sir J. Lubbock, Bart. F.R.S. &c.

The numerical values of series which are incapable of direct summation, and which slowly converge, are sometimes required, as, for example, the quantities called *b* in the *Méc. Cél.*, which are so important in astronomy and so troublesome to compute.

Suppose the slowly converging series,

$$1 + x + x^2 + x^3 + \text{ &c.}$$

of which the Napierian logarithm is

$$x + \frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} + \text{ &c.}$$

the series which expresses the Napierian logarithm evidently converges more rapidly than that which expresses the corresponding natural number; and as this is the case in other similar instances, it is desirable, especially with a view to tabulating numerical values, corresponding to different values of the variable, to have a ready mode of obtaining the numerical values of the coefficients in the series which expresses the logarithm of any series of this kind.

Let the series in question be represented by

$$1 + \alpha_1 x + \alpha_2 x^2 + \alpha_3 x^3 + \&c.$$

and let the Napierian logarithm of this quantity be represented by

$$A_1 x + A_2 x^2 + A_3 x^3 + A_4 x^4 + \&c.$$

Differentiating,

$$A_1 + 2A_2 x + 3A_3 x^2 + 4A_4 x^3 + \&c.$$
$$= \frac{\alpha_1 + 2\alpha_2 x + 3\alpha_3 x^2 + 4\alpha_4 x^3 + \&c.}{1 + \alpha_1 x + \alpha_2 x^2 + \alpha_3 x^3 + \&c.}$$

Multiplying up and equating coefficients,

$$A_1 = \alpha_1 \qquad 2A_2 + A_1\alpha_1 = 2\alpha_2 \qquad 3A_3 + 2A_2\alpha_1 + A_1\alpha_2 = 3\alpha_3$$

$$A_2 = \alpha_2 - \tfrac{3}{2} A_1\alpha_1$$

$$A_3 = \alpha_3 - \tfrac{1}{3} A_1\alpha_2 - \tfrac{2}{3} A_2\alpha_1 \qquad A_4 = \alpha_4 - \tfrac{1}{4} A_1\alpha_3 - \tfrac{2}{4} A_2\alpha_2 - \tfrac{3}{4} A_3\alpha_1$$

$$A_5 = \alpha_5 - \tfrac{1}{5} A_1\alpha_4 - \tfrac{2}{5} A_2\alpha_3 - \tfrac{3}{5} A_3\alpha_2 - \tfrac{4}{5} A_4\alpha_1,$$

of which equations the law is simple and evident.

In order to illustrate these expressions by an example, suppose it were required to calculate the coefficients of the cosines of multiples of cos θ in the developement of

$$\{1 - A \cos\theta\}^{-\frac{3}{2}}$$

this series may be expressed by

$$\mathfrak{B}_0 + \mathfrak{B}_1 \cos\theta + \mathfrak{B}_2 \cos 2\theta + \mathfrak{B}_3 \cos 3\theta + \mathfrak{B}_4 \cos 4\theta + \&c.$$

If $a = \frac{1}{2}\left\{\sqrt{1+A} + \sqrt{1-A}\right\}$ $\qquad a' = \frac{1}{2}\left\{\sqrt{1+A} - \sqrt{1-A}\right\}$

$$\mathfrak{B}_0 = \frac{1}{a_3}\left\{1 + \frac{3\cdot 3}{2\cdot 2}\frac{a'^2}{a^2} + \frac{3\cdot 5\cdot 3\cdot 5}{2\cdot 4\cdot 2\cdot 4}\frac{a'^4}{a^4} + \frac{3\cdot 5\cdot 7\cdot 3\cdot 5\cdot 7}{2\cdot 4\cdot 6\cdot 2\cdot 4\cdot 6}\frac{a'^6}{a^6} + \&c.\right\}$$

$$\mathfrak{B}_1 = \frac{2}{a^3}\left\{\frac{3a'}{2a}\right\}\left\{1 + \frac{5\cdot 3}{4\cdot 2}\frac{a'^2}{a^2} + \frac{5\cdot 7\cdot 3\cdot 5}{4\cdot 6\cdot 2\cdot 4}\frac{a'^4}{a^4} + \frac{5\cdot 7\cdot 9\cdot 3\cdot 5\cdot 7}{4\cdot 6\cdot 8\cdot 2\cdot 4\cdot 6}\frac{a'^6}{a^6} + \&c.\right\}$$

$$\mathfrak{B}_2 = \frac{2}{a^3}\left\{\frac{3\cdot 5}{2\cdot 4}\frac{a'^2}{a^2}\right\}\left\{1 + \frac{7\cdot 3}{6\cdot 2}\frac{a'^2}{a^2} + \frac{7\cdot 9\cdot 3\cdot 5}{6\cdot 8\cdot 2\cdot 4}\frac{a'^4}{a^4} + \frac{7\cdot 9\cdot 11\cdot 3\cdot 5\cdot 7}{6\cdot 8\cdot 10\cdot 2\cdot 4\cdot 6}\frac{a'^6}{a^6} + \&c.\right\}$$

the quantities $\mathfrak{B}$ are connected with the quantities b of the *Méc. Cél.* vol. i. p. 267, by the equations

$$\tfrac{1}{2} b^{(0)}_{\frac{3}{2}} = a^3 \mathfrak{B}_4 \qquad b^{(1)}_{\frac{3}{2}} = a^3 \mathfrak{B}_1 \qquad b^{(2)}_{\frac{3}{2}} = a^3 \mathfrak{B}_2$$

If $\mathfrak{B}_0 = \frac{1}{a_3}\mathbf{B}_0$ $\mathfrak{B}_1 = \frac{3a'}{a_4}\mathbf{B}_1$ $\mathfrak{B}_2 = \frac{3\cdot 5\,a'^2}{4a_5}\mathbf{B}_2$, &c. and

If $\frac{a^{12}}{a^2} = x$, the expressions for $\mathbf{B}_0$, $\mathbf{B}_1$, $\mathbf{B}_2$ are of the form

$$1 + \alpha_1 x + \alpha_2 x^2 + \alpha_3 x^3 + \&c.;$$

and the following table, calculated by Mr. Farley, shows the values of A_1, A_2, A_3, &c., α_1, α_2, α_3, &c.; and it will be seen that the coefficients A *converge*, while, on the contrary, the coefficients α *diverge*.

	$\mathbf{B}_0$	$\mathbf{B}_{11}$	$\mathbf{B}_{22}$		$\mathbf{B}_0$	$\mathbf{B}_{11}$	$\mathbf{B}_{22}$
A_1	2·2500	1·5625	1·5326	α_1	2·2500	1·5625	1·5326
A_5	·4007	·3461	·3277	α_5	7·3280	3·2319	2·9896
A_{10}	·1992	·1838	·1731	α_{10}	13·6910	5·0339	4·4391
A_{15}	·1330	·1263	·1192	α_{15}	20·0560	6·7571	5·7684
A_{20}	·1010	·0964	·0919	α_{20}	26·4210	8·4490	7·0460

In computing an isolated case of $\mathfrak{B}$, it would not be worth while to procure the values of A; but in forming an extended table of the quantities $\mathfrak{B}$, they may be employed with advantage. The quantities A are also interesting, as affording the means of resolving any series into factors. See a recent memoir by M. Cauchy in the *Comptes Rendus*.

If the series

$$1 + \alpha_1 x + \alpha_2 x^2 + \alpha_3 x^3 + \&c. = 1 + X,$$

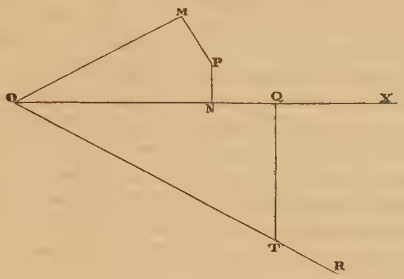
$$\text{the logarithm} = X - \frac{X^2}{2} + \frac{X^3}{3} - \frac{X^4}{4} + \&c.;$$

and, by expanding, the expression for the logarithm might be obtained in terms of α_1, α_2, α_3, &c.; but as the indices of the quantities increased, the law would not be easy to exhibit, and the equations would be altogether unmanageable for the computor.

Description of an Instrument for calculating the Correction of a Transit Observation for Collimation, Level, and Azimuth Errors. By Professor Challis.

"The collimation, level, and azimuth errors of a transit being respectively a, b, c, in seconds of space, the zenith distance of the observed object being z, and its north polar distance δ, the instrument I am about to describe performs the calculation of $(a + b \cos z + c \sin z) \times \frac{\operatorname{cosec}\delta}{15}$, that is, the reduction of the observed time of transit to the time of meridian transit. The manner of

effecting this depends on the following geometrical considerations. For simplicity, a, b, c, z, and δ will at first be supposed to be positive quantities. From an origin O draw a line of abscissæ O X, and another line O M, making with O X an angle equal to z.



Take O M equal in length to b on an arbitrary scale, and from M draw M P at right angles to O M towards O X, and equal in length to c. Then, P N being drawn perpendicularly on O X, O N is the sum of the projections of O M and M P on O X, that is, $b \cos z + c \sin z$. Set off on O X the additional quantity N Q equal to a; then $OQ = a + b \cos z + c \sin z$. Draw an indefinite line O R, making with O X, on the side opposite to O M, an angle equal to $90° - \delta$, so that the angle M O R is equal to the latitude of the Observatory. Lastly, draw Q T at right angles to O X, cutting O R in T. Then, if O R be made a scale of equal parts commencing at O, and if the unit of this scale be fifteen times the unit of the scale from which a, b, and c were cut off, it is clear that the reading O T will be $OQ \times \frac{\text{cosec } \delta}{15}$, which is the quantity it was required to calculate.

"The preceding geometrical considerations apply in the mechanical construction of the instrument as follows. The point O is the centre of a brass circular plate, movable about a vertical axis passing through this point; and on the plate are engraved, first, the scale line O R, continued both ways from O across the plate, for the purpose of taking account of negative corrections, and next, two scale lines at right angles to each other, in both directions from O, to serve for setting off positive and negative level and azimuth errors, the positive direction of the scale line for level error making, with the positive direction of the correction-scale O R, an angle equal to the latitude of the Observatory. At a short distance from the circular plate, and in a direction parallel to the arbitrary fixed direction O X, there is placed a straight edge, for the purpose of guiding the motion of two bars, which carry two fine parallel threads of blackened unspun silk over the surface of the plate, the direction of the threads being perpendicular to the straight edge. The interval between the threads is made equal to the collimation error (without regarding its sign), by means of a scale engraved on a brass plate to which one of the bars is at-

tached, and an index fixed to the brass plate to which the other bar is attached, the two plates being clamped together by a screw, when the threads are set at the required interval. The screw-head serves for a handle to move the threads. For the purpose of setting the circle in any proposed instance, its upper surface is graduated close to the circumference from 0° to 130° of positive north polar distance, and from 0° to 60° of negative north polar distance, the place of the zero of the graduation being chosen arbitrarily. The fixed index which points to the north polar distance is in such a position that its reading is zero, when the scale O R coincides in direction with the threads and the positive side of the scale is directed *from* the straight edge which guides the motion of the threads. Also the direction in which the positive numbers of the graduation increase, is determined by making the reading +90°, when the positive direction of O R coincides with the positive direction of O X.

"According to these arrangements the calculation is performed simply as follows. First, the point P is marked on the circular plate by means of the level and azimuth scales, and the threads are separated by an interval equal to the collimation error by means of the collimation scale. These operations, once performed, apply to all observations for which the collimation, level, and azimuth errors are the same. Next, for a particular observation, the circle is moved till the index of the graduation points to the north polar distance of the object: then, the point P being bisected by one of the threads, the other cuts off from O R the distance O T, which being read by the scale is the quantity sought. The bisection of P is made by one or the other of the threads, according as the collimation error is positive or negative.

"It is proper to mention several other details in the construction of the machine, and certain precautions for ensuring expedition and accuracy in the use of it. For marking readily the position of the point P, a ruled square, the sides of which serve for the level and azimuth scales, is engraved on the plate, its centre coinciding with the centre of motion of the circle. The side of the square is 6 inches, and half an inch corresponds to one second of space, so that the extent of the scales is $\pm 6''$. The ruled lines are one-twentieth of an inch apart, and, consequently, mark tenths of a second. By estimation the position of P may be marked to the hundredth of a second. The diameter of the circle is 15 inches, and the greatest amount of correction that can be read from the correction scale is $\pm 1^s$. The hundredths of a second of time are marked on this scale, and thousandths may be read by estimation. The collimation-scale extends to $7''$. The two threads are adjustible to parallelism, and when the index of the collimation-scale points to zero, it is so arranged that one thread shall be vertically above the other, the threads being let into grooves at their extremities. The lower of the two pieces of brass to which the bars carrying the threads are attached, is fastened to a rectangular piece of box-wood, which slides in a brass trough, one vertical side of which

is the guiding edge for the common motion of the threads, and against the other a spring presses to keep the box-wood close to the guiding surface. The trough rests on three screws working in the mahogany support of the instrument, and is adjustible to position by means of these screws. The words "Collimation," "Level," and "Azimuth," are engraved to distinguish the scales, and the directions in which the co-ordinates of P are to be set off are indicated by the signs + and —. Also the figures of the correction-scale have the signs + or — attached to them. The bars carrying the threads have the letters A and B engraved on them, and a card stuck in a bracket indicates which of the two threads is to be used for the bisection of P, by reference to one or the other of these letters, according as the collimation-error is positive or negative. A black-lead pencil will mark the place of P with sufficient distinctness on the brass plate by two short intersecting lines, and the lines can be readily effaced. The above precautions make it almost impossible to commit any mistake in the use of the instrument.

"It remains to mention the advantages which the instrument offers, and the degree of accuracy of which it is susceptible. For calculating the reduction to meridian transit, it has been usual to form a table of the coefficients of the collimation, level, and azimuth errors, the argument of which is the north polar distance, whence the coefficient for a proposed north polar distance may be readily deduced for insertion in the transit calculation-book. This being done, the calculation consists of three multiplications and three additions for each object. For the sake of saving time the multiplications are performed by a sliding scale. To give an idea of the advantage gained by the new instrument, it may be stated that it saves the trouble of inserting the coefficients, and the operation for obtaining the whole correction occupies no more time than one multiplication by the sliding scale. The common method may be inaccurate to one hundredth, or even two hundredths of a second, if the errors of the multiplications all lie in the same direction, whilst the machine by moderate care will give the nearest hundredth of a second. It is, however, to be said, that the indications of the instrument become more uncertain in proportion as the north polar distances are less, on account of the small inclination of the threads to the correction-scale, and that in the above construction this scale is too short to allow of reading off for north polar distance less than 30°, when the level and azimuth errors are greater than 5″ and of opposite signs, and the collimation-error is greater than 2″. To meet the case of small north polar distances an additional scale is engraved on the upper edge of that side of the trough which guides the threads, the unit being a second of space. The zero of the scale coincides with the position of a thread when it bisects the centre of the circle, and the positive numbers increase in the positive direction of O X. The process for reading off from this scale is precisely the same as for the correction-scale, but the quantity read off is $a + b \cos z + c \sin z$,

which has to be multiplied by the coefficient for collimation-error. Even this use of the instrument saves considerable time, and for stars near the pole, as *Polaris*, I find it to be somewhat more accurate than the ordinary method.

"The construction of the instrument, which required no little nicety of workmanship, has been executed for me by Mr. Simms in a very satisfactory manner.

"If the instrument be used in a latitude different from that for which it was constructed, a slight additional calculation will be required for determining the position of the point P, which may be performed by the instrument itself. For if l be the colatitude of the observatory for which the instrument was made, and z the zenith distance of an object, and if l', z' be the corresponding arcs for another observatory, we have,

$$a + b\cos z' + c\sin z' = a + b'\cos z + c'\sin z,$$
$$\text{if } b' = c\sin(l - l') + b\cos(l - l')$$
$$\text{and } c' = c\cos(l - l') - b\sin(l - l')$$

Hence b' and c' are the co-ordinates of P to be used at the latter place."

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*Description of an Instrument for obtaining the Corrections to be applied to Transit Observations.** By Mr. R. C. Carrington, of the Observatory, Durham.

Mr. Carrington, having heard that Professor Challis had proposed an instrument for correcting transit observations, set himself to work to solve the same problem. Finding his construction different from that of Professor Challis, he has had his instrument executed by Messrs. Troughton and Simms, and presented it to the Astronomical Society.

Expanding the usual formula, viz.

$$\frac{c}{\sin\delta} + \frac{i\cos(\delta - l)}{\sin\delta} + \frac{a\sin(\delta - l)}{\sin\delta},$$

(c, i, and a being the collimation, inclination, and azimuth corrections in units of 15″,)

Mr. Carrington arrives at the equivalent formula,

$c'' + c'$ cotan $\delta + c$ cosec δ; where c remains as before, and

$c' = i\cos l - a\sin l$, and $c'' = i\sin l + a\cos l$.

The geometrical construction on which Mr. Carrington's instrument depends, is this.

* In May last, the President particularly called the attention of the meeting to Mr. Carrington's instrument, and to Mr. Johnson's beautiful and accurate annual volume of observations.

Draw an indefinite right line divided into a scale of equal parts each representing 1ˢ. Cut off from the beginning a portion $= c''$; at the point of section erect a perpendicular which make $= c'$, draw from the extremity of this perpendicular a line making an angle $= 90 - \delta$ with it, and also draw a parallel to this line at the distance c from it; the last-drawn line will cut off from the original line a part equal the sum of the corrections. For, as will be easily seen, the intercepted points by the two parallel lines are respectively the cotangent and cosecant of δ to the respective radii c' and c.

The foregoing construction is very ingeniously reduced to practice by Mr. Carrington, but it would not be easy to make the matter intelligible without drawings.

Any person who is interested in the subject may inspect the instrument, and Mr. Carrington's explanation of its use, at the Society's apartments. Mr. Carrington "believes that the instrument will work to two places of decimals for all stars not less than 5° distant from the pole, and that a mistake in sign, or in the place of the decimal points, is rendered impossible." Mr. Carrington adds, "I allude to Professor Challis's instrument merely to recall the fact that his preceded mine."

Note on correcting Series of Transit Observations for Instrumental Error. By Mr. Sheepshanks.

The mechanical contrivances of Professor Challis and Mr. Carrington for this purpose, induce me to mention a method which, under certain circumstances, I found very convenient for freeing transit observations from instrumental error. Starting from the well-known formula, that the sum of corrections may be represented by $m + n \tan \text{Dec} + c \sec \text{Dec}$ (m and n are, with me, unknown quantities, to be determined from the observations themselves, c the unknown correction for collimation), I observed a large number of stars on one night, and the same stars on a following night, *with the instrument reversed.* Then, since the collimation changes its sign, and the new values of m and n have the same factors as before, the observed place of the star deduced from a *mean* of the two nights, required a correction of $m' + n' \tan \text{Dec}$. the collimation being eliminated. If the rate of the clock was considerable, the observations were corrected for rate before taking the means. I then selected the Greenwich stars near the pole, *Polaris* or δ *Ursæ Minoris* if possible, and the Greenwich stars near the equinoctial, and from these two groups obtained the value of m' and n', which were generally found with extreme accuracy. All the unknown stars were then corrected by applying $m' + n' \tan \text{Dec}$ to their mean results from the two nights' observations.

To facilitate the computation, I had cards printed of the natural tangents and secants of declination to 90°. (These may be procured at the Society's apartments.) The advantages are that in *cataloguing* you save the trouble of determining the level

azimuth and collimation errors, and if your instrument be faultless, and the Greenwich catalogue perfect, have no error left except the mere error of observation, which, when fourteen wires are noted, is very trifling. There is only one reduction to the mean place for two observations. Some observations of my own, and some made by Mr. Hartnup at my request, lead me to think that in two fine nights, a catalogue of quick moving stars may be formed, in which an error of $0^s{\cdot}05$ would be somewhat unusual.

On the Weights to be given to the separate Results, and to the final Result, for Terrestrial Longitudes determined by the Observations of Transits of the Moon and Fixed Stars. By the Astronomer Royal.

This paper contains the investigations for the principal cases which occur in practice. The *weight* of any one observation is taken as the reciprocal of the square of the probable error in seconds of time. The combination-weight of an observation is the number by which it is to be multiplied, in combining it with the results of other observations.

Case 1. The transits of the moon and one star, on a single evening, are compared with the places in the *Nautical Almanac*, considered as perfectly accurate: to find the weight and probable error of the result.

To find the weight of the result;—Form the fraction whose numerator is the product, and whose denominator is the sum, of the weights of the moon-observation and the star-observation, multiply this fraction by $\left(\frac{1}{3600}\right)^2$: the product is the weight of the result.

Case 2. Transits of the moon and several stars, observed in one evening, are compared with the places in the *Nautical Almanac*, supposed accurate.

The combination-weights for the several results will be the weights of the star-observations, without respect to the observation of the moon.

To obtain the weight of the final result;—Form the fraction whose numerator is the product of the weight of the moon-observation by the sum of the weights of the star-observations, and whose denominator is the sum of the weights of the moon-observation and the star-observation; multiply this fraction by $\left(\frac{1}{3600}\right)^2$: the product is the weight of the final result.

It will easily be seen, from this rule, that very little is gained by increasing the number of *stars* observed on the same night.

Case 3. Transits of the moon and several stars are observed at the primary station, and transits of the moon and several stars (it matters not whether the number of stars is the same, or whether

the stars are identical) are observed at other stations on the same night; the tabular places of the stars are supposed perfectly accurate, but those of the moon are liable to error: to find the combination-weights and the weight of the result.

For the determined right ascension at each station: the combination-weight for the result as to moon's right ascension determined from each star will be the weight for that star, without respect to the observation of the moon. But the weight of the result for moon's right ascension determined at that station will be the fraction whose numerator is the product of the moon's weight by the sum of the weights of the stars, and whose denominator is the sum of the weights of the moon and the stars.

When the weight for each station is thus found, then the combination-weight to be used for the result for terrestrial longitude, inferred from comparison of the moon's right ascension determined at the primary station with the moon's right ascension determined at a comparison-station, is to be the weight for that comparison-station (as found in the preceding paragraph), without respect to the primary station. But the weight of the final result for terrestrial longitude will be found by forming the fraction whose numerator is the product of the weight for the primary station by the sum of the weights for all the comparison-stations, and whose denominator is the sum of the weights for the primary station and all the comparison-stations, and multiplying this fraction by $\left(\frac{1}{3600}\right)^2$, the product is the weight of the final result.

The following cases suppose no reliance on tables, either of the moon or stars:—

Case 4. Transits of the moon and one star at the primary station are compared with transits of the same objects at one comparison-station.

The weight of the result is the reciprocal of the sum of the reciprocals of the weights of the four observations, multiplied by $\left(\frac{1}{3600}\right)^2$.

Case 5. Transits of the moon and several stars observed at the primary station are compared with transits of the same objects at one comparison-station.

The combination-weights, for combining the results of the comparisons with the different stars, will depend only on the weights of observations of the stars, without respect to the observations of the moon.

The combination-weight for the result derived from comparisons with one star, will be the fraction whose numerator is the product of the two weights for that star, and whose denominator is the sum of those weights.

Suppose a similar weight to be formed in the same way from the moon-observations.

Then for the weight of the final result, form the fraction whose numerator is the product of the moon-weight, by the

sum of the star-weights, and whose denominator is the sum of the moon-weight and the star-weights, multiply this fraction by $\left(\frac{1}{3600}\right)^2$, the product is the weight of the final result.

Case 6. Transits of the moon and a single star are observed at the primary station, and at several comparison-stations.

The combination-weights for the results derived from comparison with the different stations will depend only on the weights of the observations of the moon and star at the comparison-stations, without respect to those at the primary station.

The combination-weight for each comparison-station will be the fraction whose numerator is the product of the weights of the moon and the star, and whose denominator is their sum.

Suppose a similar weight to be formed for the primary station.

Then the weight of the final result is formed by forming the fraction, whose numerator is the product of the primary-station weight by the sum of the comparison-station-weights, and whose denominator is the sum of the primary-station weights and comparison-station weights: and multiplying this fraction by $\left(\frac{1}{3600}\right)^2$, the product is the weight of the final result.

Case 7. Transits of the moon and several (e) stars are observed at several (f) stations, besides the primary station on the same evening, the same stars being observed at all.

The general case having been treated, the particular case is fixed on in which all the moon-observations have equal probable errors (each $= \mu$), and also all the star-observations (each $= \pi$). The weight of the result is, then,

$$\left(\frac{1}{3600}\right)^2 \mu \times \text{reciprocal of } \left(1 + \frac{1}{f} + \frac{1}{e}\left(1 + \frac{1}{f}\right)\frac{\mu}{\pi}\right).$$

Case 8. As an instance of the case in which all the stars are not observed at all the stations, the following is taken.

At the primary station five stars are observed with the moon. Of these, the 1st, 2d, and 3d, are also observed with the moon at the first comparison-station; the 1st and 4th at the second comparison-station; and the 1st, 4th, and 5th, at the third comparison-station. All the observations of the moon are supposed equally good, and all the observations of the stars are supposed equally good.

The general formulæ having been considered, it is supposed that the moon and star-observations are equally good; and then, V, W, X, Y, Z, referring to the five stars, and the subscript numbers to the stations, the combination-weights V_1, W_1, X_1, V_2, Y_2, V_3, Y_3, Z_3, are found to be in the proportions of the numbers 33, 100, 100, 85, 96, 49, 60, 108. The weight of the final result is,—

$$\cdot 5930 \times \left(\frac{1}{3600}\right)^2 \times \mu.$$

The individual results receive smaller combination-weights

when derived from those stations with which there is the greater number of comparisons. Again, the individual results receive smaller combination-weights when derived from comparisons made by means of stars observed at more stations. And, to illustrate the smallness of the advantage (compared with what would probably be expected) gained by increasing the number of stations and of comparisons, the probable error of the result in the above case is less than that of one comparison with one station, only in the proportion of 20 to 13.

In practice, approximate expressions for the weights, sufficiently near the truth, may be found by the following process. Set down in the form of a table of double entry, whose arguments are "stars observed" and "comparison-stations," points or marks indicating the observation. For every observation at a comparison-station where 1, or 2, or 3, or 4, &c. stars have been observed, set down the fraction $\frac{1}{2}$, or $\frac{1}{3}$, or $\frac{1}{4}$, or $\frac{1}{5}$, &c. For every observation of a star which has been observed at 1, or 2, or 3, &c. comparison-stations, set down the fraction $\frac{1}{2}$, or $\frac{1}{3}$, or $\frac{1}{4}$, &c. The products of these fractions will give nearly enough the weight for each comparison, and the sum of all the products multiplied by $\left(\frac{1}{3600}\right)^2 \times \mu$, will give nearly enough the weight of the whole. Thus, in the instance above:—

	Stars Observed.																			
	1st				2d				3d				4th				5th			
Comparison-Stations.	Observed.	Station Number.	Star Number.	Product, or Weight.	Observed.	Station Number.	Star Number.	Product, or Weight.	Observed.	Station Number.	Star Number.	Product, or Weight.	Observed.	Station Number.	Star Number.	Product, or Weight.	Observed.	Station Number.	Star Number.	Product, or Weight.
1	*	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{16}$	*	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$	*	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$								
2	*	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{12}$									*	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{9}$				
3	*	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{16}$									*	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{12}$	*	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$

The numbers thus obtained are rather less unequal than those found by the accurate investigation; and the weight of the final result, $\mu \times \left(\frac{1}{3600}\right)^2 \times \frac{7}{9}$, is rather greater than that found by the accurate investigation. But as the rule answers exactly in extreme cases (whether the number of stations and the number of stars, or either of them, be very great or very small), it cannot err much in intermediate cases. It would be sensibly erroneous if a single different star were observed at every different station; but in this case the independent investigation would be very easy.

Case 9. Observations of any or several of the preceding classes are made *on different evenings.*

The combination-weights for the results of different evenings are to be the weights found by the preceding investigations. And the weight of the final result will be the sum of these weights.

The attention of observers is particularly called to the circumstance that this is the *only* combination by which the weight of results is greatly increased. In all the preceding cases, however much the number of stars or number of comparison-stations was increased, the weight of the result could not be increased beyond a value very little greater than that for a single star at a single comparison-station. But by increasing the number of nights of observation, the weight of the final result may be increased without limit.

Measures of ε Böotis, by Mr. Fletcher.

"By a mean of four nights' measures of this star, taken under very favourable circumstances with the 6-foot equatoreal, I find,

Position 321° 40′. Distance 2″·93. Epoch 1850·41.

Note from Professor Piazzi Smyth.

"A careful examination of the heavens in a clear night has satisfied me that the stars in Lalande, 33239 and 33244, are the same. I find the following mean places with the transit and mural circle, Epoch 1850·48 :—

		Mag.	R.A.	Obs.	N.P.D.	Obs.	Epoch.
			h m s		° ′ ″		
Lalande	{33239 / 33244}	7	17 55 50·68	(3)	15 24 29·1	(3)	1850·48

On the Comet seen by Mr. Jenkins in November last.

In the *Monthly Notice* of March last, some account is given of a comet seen by Mr. Jenkins on his voyage to Rio Janeiro. It was supposed at the time that the comet thus seen might be the comet of long period which was expected in 1848, and further inquiry was made to ascertain the particulars more accurately.

Mr. Jenkins unfortunately died at Rio, but Captain Horner, the master of the Maryland (the vessel in which Mr. Jenkins sailed), states that the comet was seen on Nov. 15th, sea account : that the true time on board was $7^h\ 30^m$ P.M., latitude 13° 32′ South, long. 34° 50′ West.

The bearing of the comet from the ship was W.N.W., altitude of the nucleus 48°, and its course S.E. and N.W.; it was in sight about an hour.

Mr. Hind remarks that these data differ considerably from those previously received. The place of the comet, according to Captain Horner's particulars, would be,

R.A. $20^h\ 36^m\cdot6$. N.P.D. 85° 42′ Nov. 15, at $9^h\ 49^m$ G.M.T.

This position is quite irreconcileable with the track of the great comet of 1848 laid down by Mr. Hind, and establishes his opinion that the body seen by Mr. Jenkins is not the expected comet. M. Bomme's investigations, however, have shown that the return of the expected comet will yet be delayed for a considerable period.

Mr. Heath proposes the following rule for converting sidereal into solar time, and *versâ vice*, when the computer has no tables to assist him :—

The datum is the proposed time, solar or sidereal. The correction is thus obtained :—

Write down the proposed time, considering the hours as minutes, the minutes as seconds, after reducing the seconds to decimals of a minute; call this a. Write under this the same number, again considering the minutes as seconds, and reducing to decimals, as before; call this b. Subtract b from a, and divide the remainder by 6; this quantity is very nearly the reduction of the given to the proposed time, being *added* if the given time is mean solar time, and *subtracted* in the contrary case.

Where great accuracy is required, a small quantity is to be applied to the datum and to its correction.

Add to b one-third of its value, and carry the decimal point two places to the left. This is then to be added to the given time; call the result t.

Add to b one-thirtieth of its value, and carry the decimal point two places to the left. This is then to be added to the correction already found; call the result t'.

Then $t \pm t'$ is $\left\{\begin{matrix}\text{Sidereal}\\ \text{Solar}\end{matrix}\right\}$ Time for the Datum in $\left\{\begin{matrix}\text{Solar}\\ \text{Sidereal}\end{matrix}\right\}$ Time.

		h	m	s
Given Time	=	23	56	4·09
a	=	23	56	0·07
b	=		23	0·93
Difference	=	23	32	0·14
Correct. $= \frac{1}{6}$	=		3	55·36

If great accuracy is required :—

$$\text{Addition to Datum} = \frac{23{\cdot}9 + \frac{1}{3}\,23{\cdot}9}{100} = 0^{s}{\cdot}32\,;\quad t = 23^{h}\ 56^{m}\ 4{\cdot}41$$

$$\text{Addition to Correct.} = \frac{23{\cdot}9 + \frac{1}{30}\,23{\cdot}9}{100} = 0^{s}{\cdot}25\,;\quad t' = \quad 3\ 55{\cdot}61$$

$23^{h}\ 56^{m}\ 4{\cdot}41^{s} + 3^{m}\ 55{\cdot}61^{s} = 24^{h}\ 0^{m}\ 0{\cdot}02^{s}$ Sid. Time $= 23^{h}\ 56^{m}\ 4{\cdot}09^{s}$ Solar Time.

$23\ 56\ 4{\cdot}41 - 3\ 55{\cdot}61 = 23\ 52\ 8{\cdot}80$ Solar Time $= 23\ 56\ 4{\cdot}09$ Sid. Time.

On a Universal Reference Number for Star Catalogues. By Mr. Drach.

To remedy the inconvenience of such discordant nomenclatures as Bradley 2493, B.A.C. 6736, &c., Mr. Drach suggests that a star should be numbered by the number of seconds contained in its right ascension, and that when one or more stars have the same second of right ascension, they should be distinguished by appending letters of the alphabet, as A, B, C, for northern stars, *a*, *b*, *c*, for southern stars. Thus a star numbered 6736 would be a star having a right ascension of 6736^s or $1^h\ 52^m\ 16^s$.

This method would be very simple if we divided the circle decimally; perhaps with our sexagesimal divisions it might be more convenient to separate the hours, as in Piazzi, and to set each star down by its hour of right ascension, with the overplus in seconds: thus, instead of 6736, to write I, 3136, somewhat as Piazzi has done.*

Mr. Drach appends a list of the doublet and triplet stars in the B.A.C., *i.e.* of those stars which fall under the same second, and which, therefore, would require additional distinguishing symbols. There is only one quadruplet.

* It would not be easy to give *permanent* names thus, as precession alters the stars every year, and in very different ways.

ERRATUM.

Vol. x., p. 158, *for* γ *Draconis, read* γ *Virginis.*

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ERRATA.

Vol. IX. p. 221, *Ceres*, July 13, Comp^{d}—Obs^{d} R.A., *for* $+12^{s}\cdot64$, *read* $+11^{s}\cdot64$.

Vol. X. — 23, line 11, *for* August 19, *read* August 10.

— — 25, — 25, *for* Hippesley, *read* Hippisley.

— — 40, — 26, *for* Leary not mounted, *read* Carey not inverted.

— — 50, — 16 from the bottom, *for* any, *read* my.

— — 94, — 24, *for* 373397·7, *read* 37339·7.

— — 138, — 32, *for* $1\frac{1}{2}$-inch pine boarding, *read* $\frac{1}{2}$-inch pine boarding.

— — 142, — 13 from bottom, *for* $+17°$, *read* $+71°$.

— — 158, *for* *γ Draconis*, *read* *γ Virginis*.

— — 182, line 2, *for* $\frac{a^{12}}{a^{2}}$, *read* $\frac{a'^{2}}{a^{2}}$.

— — 193, — 24, *for* add to, *read* take from.

last line but two, *for* $\frac{23\cdot9+\frac{1}{30}23\cdot9}{100} = 0^{s}\cdot25$; $t = 3^{m}\,55^{s}\cdot61$,

read $\frac{23\cdot9-\frac{1}{30}23\cdot9}{100} = 0^{s}\cdot23$; $t' = 3^{m}\,55^{s}\cdot59$.

last line but one, and last line,

	h	m	s		m	s	h	m	s
for	23	56	4·41	+ 3	55·61	=	24	0	0·02,
read	23	56	4·41	+ 3	55·59	=	24	0	0·00.
for	23	56	4·41	− 3	55·61	=	23	52	8·80,
read	23	56	4·41	− 3	55·59	=	23	52	8·82.

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